Amendments to the Specification are set forth in the below full paragraphs being amended or added.

On page 6 of the corresponding PCT application PCT-P004US-10020641, please amend the second and third paragraphs of the "Brief Description of the Drawing" section, as follows:

Fig. 1 is a block diagram issstrating the format of a data chunk in a communication network router; [[and]]

Fig. 2 is a block diagram illustrating the format of the chunk header of Fig. 1 in more detail; and [[.]]

On page 6 of the corresponding PCT application PCT-P004US-10020641, as the fourth paragraph in the "Brief Description of the Drawing" section, add the following paragraph:

FIG. 3 is a simplified block diagram of a router.

On page 11 of the corresponding PCT application PCT-P004US-10020641, as new paragraphs in the "Detailed Description" section, add the following paragraphs between the first full paragraph on the page beginning with, "In an embodiment of the present invention, a 400 byte ...." and the second full paragraph

on the page beginning with, "In operation, a receiving ASIC ....":

FIG. 3 is a simplified block diagram of a router 110, according to an embodiment of the present invention. Router 110 includes an ingress side line shelf 1101 and an egress side line shelf 1104. In some embodiments, ingress and egress line shelves 1101 and 1104 are a single unit, but in FIG. 3 they are illustrated for clarity as separate units. A router also includes a switching fabric. A fabric is a collection of devices which cooperatively provide a general routing capability. One example of a switching fabric is a centralized crossbar. Router 110 includes an optical switch 19 configured as a crossbar. Router 110 further includes arbiter (ARB) shelves 1102 and 1103 and an optical switch shelf 1105. A typical system includes four optical switch shelves 1105, two ARB shelves 1102 and 1103, and up to 64 line shelves 1101, 1104 in combination. One skilled in the art could vary these combinations, which are used strictly to illustrate the essential elements of the invention.

Within ARB shelf 1102 is contained a central arbiter module (CAM) 13 which is designated the active CAM. Active CAM 13 is the central point of arbitration which passes information both to optical switch shelf 1105 through a link 118 and to an arbiter interface module (AIM) 14-1 through 14-N through links 116.

Active CAM 13 determines for each switch cycle the configuration of each optical switch cartridge 19 in shelf 1105. There is only one active central arbiter module for the entire router.

Within router 110 there are two concepts of a cycle: a clock cycle and a chunk period. A chunk is defined as a uniformly sized piece of information that is passed through optical switch cartridge 19 during one cycle of the switch. All information moves through optical switch cartridge 19 in chunks. A chunk is a fixed sized quantity of information, which in this particular embodiment is 330 nanoseconds long. An actual chunk contains 400 bytes of payload information and on the order of 50 bytes of overhead, for example headers and trailers. After a chunk passes through optical switch cartridge 19, then before another chunk can pass through, the configuration of optical switch cartridge 19 is typically changed.

In each optical switch cycle there is a segment of time during which chunks of information go through optical switch cartridge 19 and another segment of time during which the optical switch cartridge 19 is reconfigured for a next chunk. These two segments of a switch cycle, termed respectively "dark period" during which optical switch cartridge 19 is reconfigured and essentially no information passes through it and the "light

period" during which information passes through the optical switch, are together termed a "chunk period".

Active CAM 13 determines the configuration for the optical switch and must do so for every chunk period. Active CAM 13 receives request information when packets arrive in the router. Eventually, the requests make their way to active CAM 13. Active CAM 13 then analyzes all the requests from the various input sources and passes configuration information for a chunk period through links 118 to an optical switch ASIC 20 in optical switch shelf 1105. Active CAM 13 also passes grants through links 116 to AIM modules 14-1 through 14-N. AIM modules 14-1 through 14-N then pass that grant information back to ingress ASICs 12-1 through 12-N through fiber optic links 114. Ingress ASICs 12-1 though 12-N receive the grant and create the actual information payload that is in a chunk. That information payload is then passed to internal optics ASIC 11-1 through 11-N. The internal optics ASICs 12-1 through 12-N take the information payloads, append Forward Error Correction (FEC) information and encapsulate them into chunks.

Forward Error Correction is used to correct any bit errors incurred through the optical switch at the egress internal optics ASIC 17-1 through 17-N. In this fashion chunks of information from the ingress internal optics ASICs 11-1 through 11-N pass

through a fiber optic link 110 and subsequently through optical switch cartridge 19. The chunks then pass through links 120 to egress internal optics ASIC 17-1 through 17-N.

Egress internal optics ASIC 17-1 through 17-N receive the chunk information and use the FEC information to correct any bit errors that occurred in the chunk. Once that correction is complete, egress internal optics ASICs 17-1 through 17-N pass the chunk information to egress ASICs 18-1 through 18-N, from which the information is then passed out to the destination ports of Router 110.

A standby CAM 15 in standby ARB shelf 1103 provides additional fault tolerance. In the event of any failure in active CAM 13, standby CAM 15 is available to continue making decisions on configuration information for the optical switch on a chunk-by-chunk basis. In standby ARB shelf 1103, are also standby AIM modules 16-1 through 16-N. Similar to links 116, links 115 communicate from standby CAM 15 to AIM modules 16-1 through 16-N, and links 114 pass the standby grant information from standby AIM modules 16-1 through 16-N to ingress ASIC 12-1 through 12-N.

Accordingly, ingress ASICs 12-1 through 12-N receive a grant from AIM modules 14-1 through 14-N or 16-1 through 16-N and build

the chunk information that is passed on to internal optics ASICs 11-1 through 11-N. The information used to build chunks is provided by the packets arriving from the input interface of Router 110 and are then queued up in ingress ASICs 12-1 through 12-N. Ingress ASICs 12-1 through 12-N make requests to AIM modules 14-1 through 14-N and 16-1 through 16-N that are passed on to active CAM 13 and standby CAM 15. Those requests are for chunks of information to go through optical switch cartridge 19. Active CAM 13 and standby CAM 15 make the decision which requests to honor, and the resulting configuration control is passed to optical switch cartridge 19 through links 118 and 119. At the same time, grants based on that decision are passed back to AIMs 14-1 through 14-N and 16-1 through 16-N, and then on to ingress ASICs 12-1 through 12-N through links 114. Ingress ASICs 12-1 through 12-N receive a grant and then access chunk building instructions associated with the grant out of a queue. The chunk building instructions specify which packets to assemble into a uniform sized chunk payload containing 400 bytes of information. Ingress ASICs 12-1 through 12-N send those chunk payloads on to internal optics ASICs 11-1 through 11-N to be sent through optical switch 19.

Active CAM 13 distributes timing through the rest of router system 110, with the objective to get the switch configuration control information to optical switch 19 concurrently with the

arrival of a corresponding data chunk that is built at ingress ASICs 12-1 through 12-N and passed through internal optics ASICs 11-1 through 11-N. The control information and the corresponding data chunk have to arrive simultaneously at optical switch 19. Alignment is very critical, in that there is a particular time window within which chunks of information must arrive at optical switch 19 in order to pass through the switch. If the arrival of a chunk is too early or too late relative to reconfiguration of the optical switch, then the chunk will be truncated based on the new optical switch configuration. Accordingly, the chunk data must be aligned through the switch during a "light period" and in between the "dark periods" when the switch is being reconfigured. In the present example, the chunk period is roughly 330 nanoseconds, consisting of chunk information roughly 280 nanoseconds long and a dark period 50 nanoseconds long. Of the 50-nanosecond dark period, it actually requires roughly 40 nanoseconds to reconfigure the switch, leaving approximately a 5-nanosecond margin at either side of the dark period for aligning the chunk information with that time window properly, in order not to truncate the chunk information as it goes through the optical switch.

The optical switch has, in the current implementation, 64 inputs that each go to any of 64 outputs. At any given chunk period, any of the 64 inputs can be connected to any of the 64

outputs, with one-to-one mapping between inputs and outputs as the only restriction. There are no other restrictions on mapping of input to output at any chunk period. Thus, the current optical switch is a complete crossbar. The configuration information tells optical switch ASIC 20 how to configure the switch inputs and outputs in a given chunk period.

Referring to the previously described operation, packets that come into router 110 at the source of the router go to ingress ASICs 12-1 through 12-N, which send requests to CAM 13, 15 and receive grants that come back from active CAM 13. Ingress ASICs 12-1 through 12-N build information chunk payloads, which have a specific destination within the router in order to go out of the router on a particular output port. Configuration information that is sent out from active CAM 13 to optical switch cartridge 19 tells how to configure the inputs to the outputs of optical switch cartridge 19, such that packets overall are switched from the desired input to the desired output of router 110.

Packets come in through the input of router 110, having packet sizes in a range from approximately 40 bytes up to approximately 9600-byte "jumbo" packets. At ingress ASICs 12-1 through 12-N those packets are queued up, requests are made to CAM 13, and grants come back. Ingress ASICs 12-1 through 12-N

upon receiving a grant will extract out of its queue or multiple queues enough packet information all heading to the same destination to fill up a single chunk. Multiple small packets totaling 400 bytes that are all headed from one ingress ASIC to a common destination within router 110 can be assembled into one chunk. Therefore several IP packets can be accumulated and assembled to form a single chunk, which for the purpose of moving through router 110 functions as a single data unit, but is subsequently broken down into its original component packets before being delivered to a router output port.

Conversely, a large packet exceeding one chunk in size is segmented into segments of approximately 400 bytes and inserted into multiple chunks. Each segment is roughly 400 bytes. Chunks exist only while traveling within the router from the ingress side to the egress side. Once at the egress side, a chunk that contains multiple small packets is decomposed into its original packets, and chunks that contain segments of a larger packet are accumulated and then reassembled into the original larger packet. The information is then sent out of router 110 in the form of the original packets.

Thus, requests that are issued from the ingress ASIC 12-1 through 12-N are passed to an arbiter interface module (AIM). The AIM passes those requests up to the central arbiter module, which

receives requests from all the input requesting sources and on every chunk period examines all the outstanding requests and decides which request to honor to configure the switch for that particular chunk period. Active CAM 13 then sends configuration information to the optical switch, so that the switch can be configured to honor that request. It also sends a grant back through the AIM modules to ingress ASICs 12-1 through 12-N. Those grants, associated with the requests that were previously made, instruct ingress ASICs 12-1 through 12-N which configuration the optical switch will be on a future chunk period, so that the ingress ASICs can form chunks to send through the optical switch.

The arrows in FIG. 3 show the paths that are used to distribute timing information throughout router system 110. Not shown for simplicity in FIG. 3 are the request paths that go from ingress ASICs 12-1 through 12-N to AIM modules 14-1 through 14-N and then on to active CAM 13. CAM 13 grants requests a number of chunk cycles in advance (typically six chunk periods) of when the optical switch is actually needed in a given configuration. Using a pipeline process, it takes approximately six chunk periods for configuration information to actually make its way to optical switch cartridge 19 and also roughly six chunk periods for the grants to make their way back to ingress ASIC 12-1 through 12-N,

to build the chunk, and to forward the chunk to the optical switch. Accordingly, the data path from active Cam 13 through the ingress and internal optics ASICs to the optical switch is roughly six chunk periods long, as is the path of configuration information from active CAM 13 through optical switch ASIC 20 to optical switch cartridge 19.

In some embodiments (see U.S. application Ser. No. 09/703,057, cited above), ingress ASICs 12-1 through 12-N and egress ASICs 18-1 through 18-N are each contained in a packet forwarding module. Each packet forwarding module in turn is interconnected with router input and/or output ports through facility interfaces. In some embodiments each packet forwarding module receives and/or sends duplicate input data packets in parallel through paired redundant facility interfaces. A group of N packet forwarding modules are interconnected into a protection group configured for one-for-N protection, having one protect packet forwarding module for N working packet forwarding modules, where N is a positive integer greater than two, typically 4.

In FIG. 3, paths or links that are contained within a respective shelf 1101 through 1105 are electrical in nature. They are contained within a given shelf, such that a path distance is a relatively short fixed distance between modules on

a backplane. On the other hand, paths that go between shelves 1101-1105 are fiberoptic links, which are variable in distance and thus in propagation delay, depending on locations of various racks and shelves within overall router system 110. The timing distribution mechanism must deal with those variable lengths, such that the data and the configuration control still reach the optical switch cartridge simultaneously.